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[Claim(s)]

[Claim 1]An inverter device whose energization angle width of a rising portion of said trapezoid wave and a falling part is 72 degrees **3 degrees in an inverter device which operates BL motor or a reluctance motor by a trapezoid wave.

[Claim 2]An inverter device whose energization angle width of a rising portion of said trapezoid wave and a falling part is 51 degrees **3 degrees in an inverter device which operates BL motor or a reluctance motor by a trapezoid wave.

[Claim 3]An inverter device whose energization angle width of a rising portion of said trapezoid wave and a falling part is 70 degrees **3 degrees in an inverter device which operates BL motor or a reluctance motor by a trapezoid wave.

[Claim 4]An inverter device whose energization angle width of a rising portion of said trapezoid wave and a falling part is 72 degrees **3 degrees in an inverter device which operates an induction motor by a trapezoid wave.

[Claim 5]An inverter device whose energization angle width of a rising portion of said trapezoid wave and a falling part is 51 degrees **3 degrees in an inverter device which operates an induction motor by a trapezoid wave.

[Claim 6]An inverter device whose energization angle width of a rising portion of said trapezoid wave and a falling part is 70 degrees **3 degrees in an inverter device which operates an induction motor by a trapezoid wave.

[Claim 7]An inverter device whose energization angle width of a rising portion of said false sine wave and a falling part it is operated in an inverter device which operates BL motor or a reluctance motor by a false sine wave whose rising portion and falling part of a trapezoid wave are a sine wave, and is 76 degrees **3 degrees.

[Claim 8]An inverter device whose energization angle width of a rising portion of said false sine wave and a falling part it is operated in an inverter device which operates BL motor or a

reluctance motor by a false sine wave whose rising portion and falling part of a trapezoid wave are a sine wave, and is 53 degrees **3 degrees.
[Claim 9]An inverter device whose energization angle width of a rising portion of said false sine wave and a falling part it is operated in an inverter device which operates BL motor or a reluctance motor by a false sine wave whose rising portion and falling part of a trapezoid wave are a sine wave, and is 77 degrees **3 degrees.
[Claim 10]An inverter device whose energization angle width of a rising portion of said false sine wave and a falling part it is operated in an inverter device which operates an induction motor by a false sine wave whose rising portion and falling part of a trapezoid wave are a sine wave, and is 76 degrees **3 degrees.
[Claim 11]An inverter device whose energization angle width of a rising portion of said false sine wave and a falling part it is operated in an inverter device which operates an induction motor by a false sine wave whose rising portion and falling part of a trapezoid wave are a sine wave, and is 53 degrees **3 degrees.
[Claim 12]An inverter device whose energization angle width of a rising portion of said false sine wave and a falling part it is operated in an inverter device which operates an induction motor by a false sine wave whose rising portion and falling part of a trapezoid wave are a sine wave, and is 77 degrees **3 degrees.

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the inverter device which controls BL motor, a reluctance motor, and an induction motor the optimal.
[0002]
[Description of the Prior Art]The synchronous motor (following BL motor: it abbreviates to a brushless motor) which made the permanent magnet the rotation child conventionally, the reluctance motor (the motor which has a rotation child of salient pole structure.) which turns because a rotation child's magnetic resistance changes with rotation child positions the motor to which magnetic resistance is changed by providing an opening in a rotation child, the motor to which magnetic resistance is changed combining a permanent magnet, etc. -- containing, when carrying out rate control, It is necessary to change the impressed electromotive force of a motor by revolving speed or load, and, [a control device] [as a means to change impressed electromotive force] PAM (Pulse Amplitude Modulation: pulse wave high price) control, PWM (Pulse Width Modulation: pulse width) control, etc. are used.
[0003]When motor impressed electromotive force controls BL motor and a reluctance motor,

When it is necessary to synchronize a voltage phase according to a rotation child's position and uses the advanced rotation child position transducer of 100 or more pulses of numbers per one revolution, use the sine wave PWM control which approximates impressed electromotive force to a sine wave synchronizing with the detected phase, but. Usually, the SENSARESU method which detects the induction voltage of the method with a sensor which performs a rotation child position transducer with the magnetization detector of each phase, and the motor under rotation, and explores a rotation child position is in use, and there is much the equal-width PWM control or PAM control which controls BL motor and a reluctance motor by a rectangle wave.

[0004]When impressing rectangle wave voltage, there was much voltage called the 180-degree energization shown in drawing 4 and voltage called the 120-degree energization shown in drawing 5 conventionally. This is because the positive/negative signal of one pulse of the N pole and the S pole will be acquired to one cycle per one phase, each phase will detect with the degree of phase angle which is 120 degrees, if the above-mentioned rotation child magnetization detector is used when operating 3 phase motor, so the pole position in six modes can be distinguished per 1 electricity cycle.

[0005]However, 180-degree energization and 120-degree energization had a fault with a large vibration by the 5th harmonics and the 7th harmonics, and the oscillating measure was indispensable for the fan use asked for silence.

[0006]

[Problem to be solved by the invention]In the inverter device which impresses the rectangle wave voltage called the above conventional 180-degree energization or 120-degree energization, and performs motor operation, Vibration and noise are loud because of the 5th time harmonics [7th] that said rectangle wave voltage contributes to vibration most among the harmonics ingredients which it essentially has, and the reduction in vibration and low noise-ization are called for strongly.

[0007]this invention reduces the 5th time harmonics [7th] that the rising portion and falling part of trapezoidal wave voltage or a trapezoid wave impress the false sine voltage which is a sine wave to a motor, and contribute to vibration most -- low vibration -- low -- the inverter device which performs noise motor operation is provided.

[0008]

[Means for solving problem]In order to solve this SUBJECT, this invention analyzes a time [when the false sine voltage whose rising portion and falling part of trapezoidal wave voltage or a trapezoid wave are a sine wave has] harmonics ingredient by Fourier series, The inverter device which performs motor operation by the optimal, trapezoidal wave voltage wave-like or optimal false sine voltage waveform is provided.

[0009]thereby -- low vibration -- low -- the inverter device which performs noise motor

operation can be obtained.

[0010]

[Mode for carrying out the invention]Drawing 1 is a voltage wave form chart of this example. Drawing 1 (a) shows a trapezoidal wave voltage waveform, and drawing 1 (b) shows the voltage waveform (it abbreviates to a false sine wave below) whose rising portion and falling part of a trapezoid wave are a sine wave. The lower right will call a falling part the portion from which a rising portion and voltage change to ** the portion from which voltage changes to an upward slant to the right in each waveform.

[0011]The trapezoid wave from which voltage changes to an upward slant to the right from the position of 0 degree of a 180-degree trapezoid wave to the degree A of phase angle as shown in drawing 1 (a), Or as shown in drawing 1 (b), when voltage asks for the false sine wave which changes to an upward slant to the right by Fourier series from the position of 0 degree of a 180-degree false sine wave to the degree A of phase angle, These waveforms are symmetrical waves, and since it is an odd function, a cos paragraph does not exist, but only a sin paragraph exists, and if a harmonics degree is set with n, n exists only odd number (n= 1, 3, 5 and 7, --). and 3 phase voltage (drawing 1 -- U phase voltage.) which makes one cycle 360 degrees spatially, makes one cycle of impressed electromotive force the motor which shifted and carried out the three-phase wire connection of every 120 degrees of the phases with 360 degrees, and has every 120 degrees phase contrast Since it is operating by V phase voltage, W phase voltage, and display, the harmonics ingredient of the 3rd multiple is negated mutually, there is and it stops existing. Therefore, the harmonics degree n becomes 1, 5, 7, 11, 13, and --. Of the ingredient which these 5th harmonics and the 7th harmonics make generate a 6 times as much vibration as fundamental frequency, vibration becomes large (****** is strongly), so that that value is large.

[0012]When said degree A of phase angle is 0 degree in the trapezoid wave and false sine wave which are shown in drawing 1 (a) and drawing 1 (b), it becomes a rectangle wave of 180-degree energization, It will become a formula (1) if the size of the voltage of the n-th harmonics ingredient of the rectangle wave shown in drawing 6 is made into V_{**} (n) by the ratio which set the size of the fundamental wave ingredient at the time of said 180-degree energization to 1 (100%).

[0013]

[Mathematical formula 1]

$$V_{**}(n) = \frac{1}{n} \times \cos(n \times A) \quad \cdots\cdots\cdots (1)$$

[0014]It will become a formula (2) if the size of the voltage of the n-th harmonics ingredient of said trapezoid wave is made into V_{stand} (n) by the ratio which set the size of the fundamental

wave ingredient at the time of said 180-degree energization to 1 (100%).

[0015]

[Mathematical formula 2]

$$V_{台}(n) = \frac{180}{n^2} \times \frac{\sin(n \times A)}{\pi A} \cdots\cdots (2)$$

[0016]It will become a formula (3) if the size of the voltage of the n-th harmonics ingredient of said false sine wave is similarly made into $V_{positive}(n)$ by the ratio which set the size of the fundamental wave ingredient at the time of said 180-degree energization to 1 (100%).

[0017]

[Mathematical formula 3]

$$V_{正}(n) = \frac{1}{\sin A}\left[\frac{\sin((n-1)A)}{2n(n-1)} + \frac{\sin((n+1)A)}{2n(n+1)}\right] \cdots\cdots (3)$$

[0018]In the case of n= 1, in a formula (3), it becomes like a formula (4) here.

[0019]

[Mathematical formula 4]

$$V_{正}(1) = \frac{1}{\sin A}\left[\frac{\pi A}{360} + \frac{\sin 2A}{4}\right] \cdots\cdots (4)$$

[0020]In the case of the 5th harmonics that will contribute to vibration most if a formula (2) shall be developed and a round term of a trapezoidal wave voltage waveform shall be 360 degrees, and the 7th harmonics. As for the 5th harmonics ingredient, if said 36 degrees (180degree/5) of degrees A of phase angle become, the ingredient will be set to 0 (formula (5)), and similarly, if said 25.71 degrees (180degree/7) of degrees A of phase angle become, as for the 7th harmonics ingredient, it turns out that the ingredient is 0. (Formula (6)). That this ingredient is 0 means that ****** of those time harmonics is 0 when a motor rotates, and time harmonics do not generate vibration of a cause.

[0021]

[Mathematical formula 5]

$$V_{台}(5) = \frac{180}{5^2} \times \frac{\sin(5 \times 36^\circ)}{\pi \times 36^\circ}$$

$$= \frac{180}{5^2} \times \frac{\sin(180^\circ)}{\pi \times 36^\circ} = 0 \cdots\cdots (5)$$

[0022]

[Mathematical formula 6]

$$V_{台}(7) = \frac{180}{7^2} \times \frac{\sin(7 \times 25.71^\circ)}{\pi \times 25.71^\circ}$$

$$= \frac{180}{7^2} \times \frac{\sin(180^\circ)}{\pi \times 25.71^\circ} = 0 \cdots\cdots (6)$$

[0023]Therefore, if it expresses by the energization angle width of said rising portion of a trapezoidal wave voltage waveform, and a falling part, The energization angle width of a rising portion and a falling part from which the 5th harmonics ingredient serves as the minimum is 36 degrees x 2= 72 degrees, and the energization angle width of a rising portion and a falling part from which the 7th harmonics ingredient serves as the minimum is 25.71 degrees x 2= 51.42 degrees.
[0024]Next, when each degree of phase angle which the formula (2) was developed, and drawing 2 illustrated the degree A of phase angle to the X-axis, illustrated the size of each harmonics to the Y-axis, and it described above from this is chosen, it turns out that the ingredient of the 5th harmonics and the 7th harmonics is 0.
[0025]By drawing 2, the first harmonics ingredient is called a fundamental wave ingredient, it is a fundamental wave which contributes to the number of rotations of a motor, and the value which broke the content by the fundamental wave since the ingredient of each harmonics to the fundamental wave turned into a vibration component means ****, and vibration becomes small, so that the value is small. The effective value of each harmonics ingredient is squared two here, the square root of each sum is distorted, and it is an ingredient, and since the value which broke the distortion ingredient by the effective value of the fundamental wave is ****, drawing 2 shows that the minimum of **** is 73.64 degrees in the degree A of phase angle. However, when said degree A of phase angle is 73.64 degrees, the ingredient of a fundamental wave is decreasing, Since motor impressed electromotive force decreases at the time of the basic number of rotations of a motor, it is necessary to lower the induction voltage constant of a motor. Since motor current when the same load torque is added will increase and the current capacity of a switching transistor increases, it is not a best policy, The energization angle width of 35.19 degrees with small ****, a rising portion, and a falling part is understood that the degrees A of phase angle to which **** serves as the minimum from that are 35.19 degrees x 2= 70.38 degrees from drawing 2 after 73.64 degrees.
[0026]If a formula (3) shall be developed and a round term of a false sine voltage waveform shall be 360 degrees, In the case of the 5th harmonics that contribute to vibration most, and the 7th harmonics, as for the 5th harmonics ingredient, if said 37.76 degrees of degrees A of phase angle become, the ingredient will be set to 0 (formula (7)), and similarly, if said 26.29 degrees of degrees A of phase angle become, as for the 7th harmonics ingredient, it turns out that the ingredient is 0. (Formula (8)). That this ingredient is 0 means that ****** of those time harmonics is 0 when a motor rotates, and time harmonics do not generate vibration of a cause.

[0027]
[Mathematical formula 7]

$$V_{(5)} = \frac{1}{\sin(37.76^\circ)}\left[\frac{\sin(4\times37.76^\circ)}{2\times5\times4} + \frac{\sin(6\times37.76^\circ)}{2\times5\times6}\right] = 0 \cdots\cdots (7)$$

[0028]

[Mathematical formula 8]

$$V_{(7)} = \frac{1}{\sin(26.29^\circ)}\left[\frac{\sin(6\times26.29^\circ)}{2\times7\times6} + \frac{\sin(8\times26.29^\circ)}{2\times7\times8}\right] = 0 \cdots\cdots (8)$$

[0029]Therefore, if it expresses by the energization angle width of said rising portion of a false sine voltage waveform, and a falling part, The energization angle width of a rising portion and a falling part from which the 5th harmonics ingredient serves as the minimum is 37.76 degrees x 2= 75.52 degrees, and the energization angle width of a rising portion and a falling part from which the 7th harmonics ingredient serves as the minimum is 26.29 degrees x 2= 52.58 degrees.

[0030]Next, when each degree of phase angle which the formula (3) was developed, and drawing 3 illustrated the degree A of phase angle to the X-axis, illustrated the size of each harmonics to the Y-axis, and it described above from this is chosen, it turns out that the ingredient of the 5th harmonics and the 7th harmonics is 0.

[0031]As for the minimum of ****, drawing 3 shows that they are 38.30 degrees x 2= 76.60 degrees with the degree A of phase angle by the energization angle width of 38.30 degrees, a rising portion, and a falling part.

[0032]At the time of 180-degree energization of a conventional example, since the degree A of phase angle of a formula (1) is 0 degree, the ingredient of a fundamental wave is received, From a formula (9), the 7th harmonics ingredient of the 5th harmonics ingredient shall be 14.3% from 20% and a formula (10), the degree A of phase angle of a formula (1) shall be 30 degrees at the time of 120-degree energization, and the absolute value of the 7th harmonics ingredient of the absolute value of the 5th harmonics ingredient is 12.4% from a formula (12) 17.3% in a formula (11). And as for **** to a fundamental wave, a formula (13) and a formula (14) show that 180-degree energization and 120-degree energization are 24.6%.

[0033]

[Mathematical formula 9]

$$V_{(5)} = \frac{1}{5} \times \cos(5\times0^\circ)$$

$$= \frac{1}{5} \times 1 = 0.2\ (20\%) \cdots\cdots (9)$$

[0034]

[Mathematical formula 10]

$$V_{矩}(7) = \frac{1}{7} \times \cos(7 \times 0^\circ)$$

$$= \frac{1}{7} \times 1 = 0.143\ (14.3\%) \cdots\cdots (10)$$

[0035]

[Mathematical formula 11]

$$V_{矩}(5) = \frac{1}{5} \times \cos(5 \times 30^\circ)$$

$$= \frac{1}{5} \times \cos(150^\circ) = -0.173\ (-17.3\%) \cdots\cdots (11)$$

[0036]

[Mathematical formula 12]

$$V_{矩}(7) = \frac{1}{7} \times \cos(7 \times 30^\circ)$$

$$= \frac{1}{7} \times \cos(210^\circ) = -0.124\ (-12.4\%) \cdots\cdots (12)$$

[0037]

[Mathematical formula 13]

$$歪率_{180^\circ} = \frac{\sqrt{V_{矩}(5)^2 + V_{矩}(7)^2}}{V_{矩}(1)}$$

$$= \frac{\sqrt{0.2^2 + 0.143^2}}{1} = 0.246\ (24.6\%) \cdots\cdots (13)$$

[0038]

[Mathematical formula 14]

$$歪率_{120^\circ} = \frac{\sqrt{V_{矩}(5)^2 + V_{矩}(7)^2}}{V_{矩}(1)}$$

$$= \frac{\sqrt{(-0.173)^2 + (-0.124)^2}}{\cos 30^\circ} = 0.246\ (24.6\%) \cdots\cdots (14)$$

[0039]If 72 degrees of energization angle width of the rising portion of a trapezoidal wave voltage waveform and a falling part become to it, the 5th harmonics ingredient will be 0 like the above-mentioned, but. If **** is 3.3% and 51.42 degrees of energization angle width of a rising portion and a falling part become 3.1% by calculation with the same 7th harmonics ingredient, as for the 5th harmonics ingredient, 0 and **** of the 7th harmonics ingredient will be 7.2% 7.0%. When the energization angle width of a rising portion and a falling part from which **** by the 5th harmonics and the 7th harmonics serves as the minimum is 70.38 degrees, the 7th harmonics ingredient is [**** of the 5th harmonics ingredient] 3.2% 3.0% 0.5%.

[0040]If 75.52 degrees of energization angle width of the rising portion of a false sine voltage waveform and a falling part become, the 5th harmonics ingredient will be 0 like the above-

mentioned, but. If **** is 2.8% and 52.58 degrees of energization angle width of a rising portion and a falling part become 2.6% by calculation with the same 7th harmonics ingredient, as for the 5th harmonics ingredient, 0 and **** of the 7th harmonics ingredient will be 7.1% 6.9%. When the energization angle width of a rising portion and a falling part from which **** by the 5th harmonics and the 7th harmonics serves as the minimum is 76.60 degrees, the 7th harmonics ingredient is [**** of the 5th harmonics ingredient] 2.8% 2.6% 0.2%.

[0041]Even if a voltage waveform decides the degree A of phase angle of drawing 1 to be 36 degrees (energization angle 72 degrees in width of a rising portion and a falling part), The delay of the dead time control which prevents simultaneous ON of the switching transistor by the time delay at the time of OFF of a switching transistor, or a circuit, variation, etc. occur, From not making it increase remarkably, change whose angle is about several degrees from drawing 2 or drawing 3 to the increase in vibration, [the allowable angle of the degree A of phase angle] If magnetization of 6000 r/min (100 r/s) and a motor is 8 pole magnetization, [the maximum speed of a motor] Since one cycle of a time wave is 2.5mS and the 20microS grade is usually required for the dead time which prevents the inconvenience of transistor simultaneous ON by the time delay at the time of OFF of a switching transistor, If 20microS shall be 360 degrees in cycle, it becomes 3 degrees and an application concerned permits about 3-degree variation.

[0042]as mentioned above, the vibration component of the motor by the 5th harmonics if the energization angle width of a rising portion and a falling part is 72 degrees when impressing trapezoidal wave voltage to a motor -- 0 -- low -- a waveform [****] being provided and, the vibration component of the motor by the 7th harmonics if it is 51.42 degrees -- 0 -- low -- a waveform [****] can be provided, and if 70.38 degrees becomes, vibration by both 5th harmonics ingredient [7th] can provide a minimum trapezoidal wave voltage waveform.

[0043]the vibration component of the motor by the 5th harmonics if the energization angle of a rising portion and a falling part is 75.52 degrees when impressing false sine voltage to a motor -- 0 -- low -- a waveform [****] being provided and, the vibration component of the motor by the 7th harmonics if it is 52.58 degrees -- 0 -- low -- a waveform [****] can be provided, and if 76.60 degrees becomes, a minimum vibration [by both 5th harmonics ingredient / 7th] false sine voltage waveform can be provided.

[0044]Although the inverter device for induction motors of the magnetization detector in the case of the above-mentioned BL motor or a reluctance motor is unnecessary and it becomes the open control without the feedback from a sensor, The view of the time harmonics of a trapezoid wave or a false sine wave is the same, and if it is a waveform of this invention, reduction of vibration by time harmonics is the same.

[0045]When the degree A of phase angle of the 5th harmonics ingredient is 72 degrees in a trapezoidal wave voltage waveform from drawing 2, Although the 7th harmonics ingredient is

set to 0 when the degrees A of phase angle are 51.43 degrees and 77.14 degrees, it is set to 0 from drawing 3 when the degree A of phase angle of the 7th harmonics ingredient is 52.96 degrees in a false sine voltage waveform, and the effect of the above-mentioned oscillating fall is the same, Since the ingredient of a fundamental wave is decreasing and motor impressed electromotive force decreases the same with having mentioned above at the time of the basic number of rotations of a motor, it is necessary to lower the induction voltage constant of a motor. Since motor current when the same load torque is added will increase and the current capacity of a switching transistor increases, it is not a best policy.

[0046]

[Effect of the Invention]as mentioned above -- if 3 phase motor is operated by the voltage waveform of this invention, vibration of the motor by time harmonics will decrease -- low vibration -- low -- the inverter device which operates a noise motor can be provided.

[Brief Description of the Drawings]

[Drawing 1](a) The voltage wave form chart of this example

(b) The voltage wave form chart of this example

[Drawing 2]The figure which expressed the size of the degree of the said phase angle, and the voltage of a harmonics ingredient in the trapezoid wave

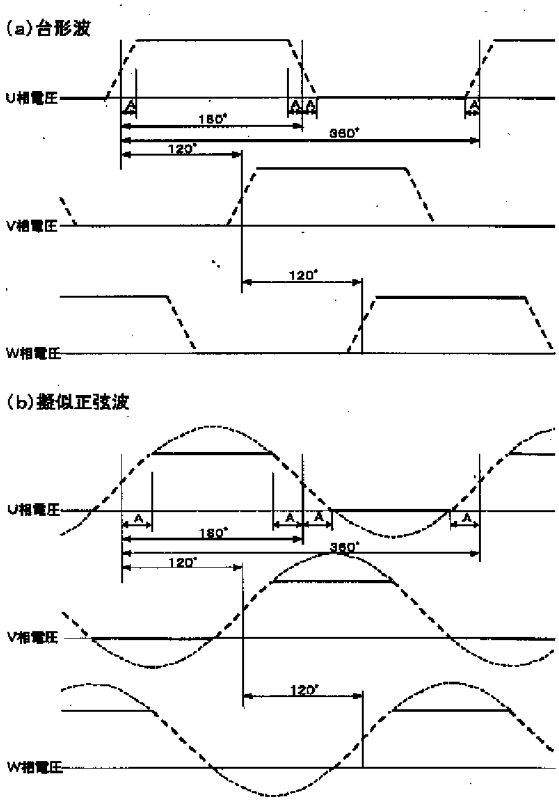
[Drawing 3]The figure which expressed the size of the degree of the said phase angle, and the voltage of a harmonics ingredient in the false sine wave

[Drawing 4]The voltage wave form chart of the 180-degree energization by a conventional example

[Drawing 5]The voltage wave form chart of the 120-degree energization by a conventional example

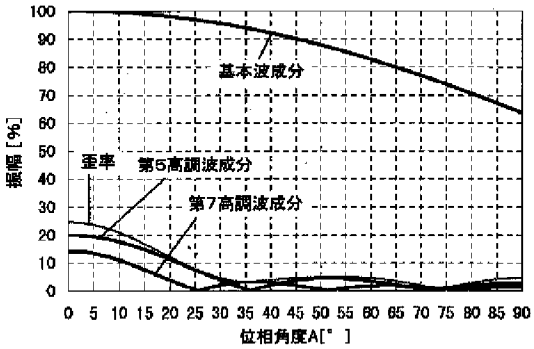
[Drawing 6]Rectangle wave voltage wave form chart

[Drawing 1]



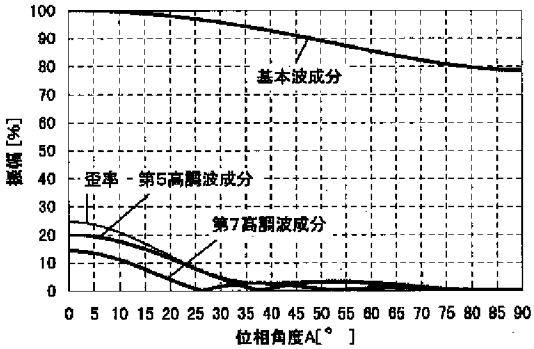
本実施例の電圧波形図

[Drawing 2]



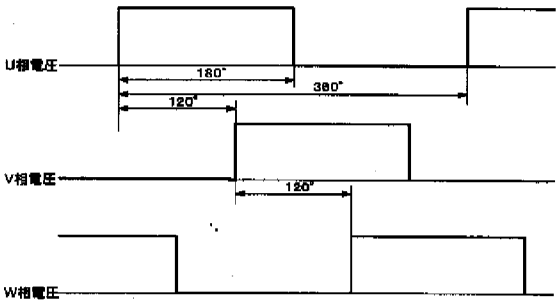
台形波において同位相角度と高調波成分の電圧の大きさを表現した図

[Drawing 3]



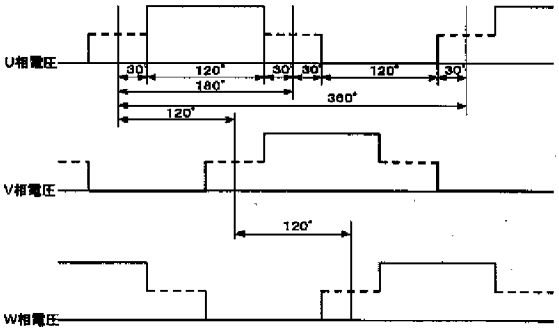
擬似正弦波において同位相角度と高調波成分の大きさを表現した図

[Drawing 4]



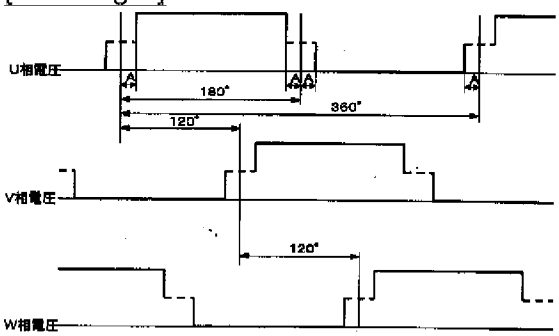
従来例で180° 通電の電圧波形図

[Drawing 5]



従来例で120° 通電の電圧波形図

[Drawing 6]



矩形波電圧波形図

[Translation done.]